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AN IMPROVED ELECTROCHEMICAL PROCESS FOR THE PRODUCTION OF POTASSIUM IODATE

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Electrochemical oxidation of iodine to potassium iodate has been studied with the use of titanium substrate metal oxide anodes in an annular flow reactor. 90–95% conversion efficiency is obtained for the oxidation at current densities of 20–25 Amp dm^{-2}. The use of metal oxide anodes with the annular flow cell design enables the attainment of high yields, lower energy costs, higher productivity of electrolyser and continuous operation of the process.

Key words: Potassium iodate, noble metal oxide anode, annular flow cell.

Potassium iodate is mainly used for iodisation of edible salt. Since iodine deficiency is prevalent in many parts of our country. Government of India has been encouraging the production and consumption of iodised salt by granting suitable subsidies to combat the maladies associated with iodine deficiency. The demand for potassium iodate is hence expected to go up to about 200 tonnes per annum by 1992. This paper deals with the salient features of an improved electrochemical process for the production of potassium iodate.

Anodic oxidation of iodine to iodate has been studied in detail using platinum, lead, graphite and graphite substrate lead dioxide (GSLD) anodes [1–5]. Process development studies have been reported for the production of potassium iodate using GSLD anode has also been reported recently [7]. In the present studies, precious metal oxide coated titanium anodes have been used for the production of potassium iodate in an Annular Flow cell [AFC]. The anodes used in the studies were supplied by the Chlor alkali section of Central Electrochemical Research Institute, Karaikudi.

Reactions for iodate formation

Reactions involved in the process are given below.

$$\text{Anode: } 2\,I^- - 2e \longrightarrow I_2 \qquad (1)$$

$$\text{Bulk: } 3\,I_2 + 6\,KOH \longrightarrow 3\,KI + 3KIO + 3H_2O \qquad (2)$$

$$3\,KIO \longrightarrow KIO_3 + 2KI \qquad (3)$$

$$\text{Overall: } 3I_2 + 6KOH \longrightarrow 5KI + KIO_3 + 3H_2O \qquad (4)$$

As seen from the overall reaction (4) the dissolution of iodine in alkali leads to the formation of iodide and iodate. On electrolysis of the alkaline solution, iodide gets oxidized to iodine as per reaction (1). The iodine discharged reacts with the bulk electrolyte forming iodide and hypoiodite (2) Hypoiodite formed decomposes to iodide and iodate as in (3) Thus iodine is completely converted to iodate by successive electrochemical and chemical reactions.

EXPERIMENTAL

The electrolytic cell used in the studies was an AFC with precious metal oxide coated titanium anode and stainless steel cathode. Flow cell was operated in the batch recycle mode with total recirculation of electrolyte. Electrolyte was prepared in a stainless steel tank and circulataed through the AFC by a centrifugal pump. Electrolysis was conducted for a duration of 5 Faradays per mole of iodine charged. The electrolytic process consists of the dissolution of iodine in potassium hydroxide solution and electrolysis of the alkaline solution. The concentration of potassium iodate in the electrolyte increases with duration of electrolysis and periodically the electrolyte is removed and cooled in the crystalliser to recover the iodate formed. Mother liquor is recycled for electrolysis after replenishing the electrolyte with equivalent quantity of iodine to the product isolated. The iodate formed in the crystalliser is centrifuged and dried. The iodate content in the electrolyte was periodically estimated by titration against standard thiosulphate solution. Yields were calculated on the basis of the isolated product and iodate content in the electrolyte. Electrolyte was continuously reused and process data were collected for a cycle of six reuses.

RESULTS AND DISCUSSION

Process conditions were optimised in the laboratory scale for the oxidation of iodine with precious metal oxide coated titanium anode. The results obtained in the trials are given in Table-I. It is seen from Table I that 90–95% yields were obtained with the metal oxide anodes under reuse conditions. The operating current density for the oxidation was 20–30 Amp dm^{-2} The product obtained in the trials was found to conform to the grade suitable for iodisation of salt.

TABLE-I: Operating data for the production of potassium iodate

1. Cell type	: Narrow gap Annular Flow cell
2. Anode	: Precious metal oxide coated titanium
3. Cathode	: Stainless steel
4. Current density	: 20–30 Amp dm^{-2}
5. Inter electrode gap	: 1–3 mm
6. pH of electrolyte	: 9.5 to 11.0
7. Cell voltage	: 3.4 to 3.8
8. Current passed	: 5 F/mole
9. No. of reuses	: Six
10. Material yield	: 90–96%
11. Energy consumption for electrolysis KWH/kg	: 2.1–2.3 KWH/kg

Comparative figures of the operating data obtained in the present trials with reported data for iodate production with GSLD anodes

in tank cells and AFC is given in Table II. It is seen from the Table that the operating current density is higher with precious metal oxide coated titanium anodes as compared to GSLD anodes. Iodate yields are also higher [90–96%] and energy consumption is lower by 10–20% in the present process. Other advantages of the improved process are (i) the easy available of metal oxide anodes in the market as compared to GSLD anodes, (ii) anode stability and (iii) the avoidance of possible lead contamination of the product.

TABLE-II: Operating data for iodate production with GSLD anode and metal oxide coated titanium anode

No.	Parameter	GSLD anode		Metal oxide coated titanium anode
		Tank cell	AFC	
1.	Cell voltage	3.5–5.5	3.4–3.8	3.4–3.8
2.	Operating current density Amp dm^{-2}	7–10	10–15	20–30
3.	Yield %	70–75	75–85	90–96
4.	Energy consumption KWH/kg	4–4.5	2.6–2.8	2.1–2.3

CONCLUSION

An improved electrochemical process with precious metal oxide coated titanium anode in an annular flow cell enables the production of iodate with 90–95% yield at current densities of 20–30 Amp dm^2. Energy consumption for electrolysis is also 10–20% lower as compared to the existing process with GSLD anode.

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